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DEC. 24. 2002

PATENT OFFICE
JAPANESE GOVERNMENT

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Date of Application: May 19, 1997

Application Number: Japanese Patent Application No. 9-128898

Applicant(s): FUJITSU LIMITED

December 26, 1997

Commissioner,
Patent Office Hisamitsu Arai (Seal)

Certificate No.09-3106754

(Document Name)	Application for Patent
(Reference Number)	9703998
(Date of Submission)	May 19, 1997
(Destination)	Commissioner of Patent Office
(IPC)	H01L 21/00
(Title of the Invention)	MOUNTING METHOD OF SEMICONDUCTOR DEVICE
(Number of Claims)	2

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(Indication of Official Fees)
(Prepayment Ledger Number) 011280
(Amount Paid) ¥ 21,000
(Lists of Submitted Documents)
(Document Name) Specification 1
(Document Name) Drawing 1
(Document Name) Abstract 1
(Number of General Power of Attorney) 9001093

[Title of Document] Specification

[Title of the Invention]

Mounting Method of Semiconductor Device

[Scope of Claim for a Patent]

[Claim 1]

A method for mounting a semiconductor chip component on a substrate by pressing so as to weld bumps of a semiconductor component and pads of the substrate and by hardening an adhesive filled between the semiconductor component and the substrate, said method characterized by:

welding the bumps to pads of the substrate by pressure before said adhesive is hardened and by releasing that pressure welding after the adhesive is hardened.

[Claim 2]

A method for mounting a semiconductor component on a substrate by moving a head for heating and pressuring, which supports the semiconductor component, so as to weld bumps of the semiconductor component and bumps on the substrate by pressure and hardening an adhesive filled between the components and the substrate by heat from the head, said method characterized by:

moving the head, which is heated to reach temperature at which said adhesive is hardened, so that the bumps press the pads before the adhesive is hardened, and by releasing a pressure welding after the adhesive is hardened.

[0001]

[Technical Field Pertinent to the Invention]

The present invention generally relates to a mounting method of a semiconductor device, and more particularly to a method of mounting a semiconductor device on a board in accordance with a COB (Chip On Board) method.

[0002]

[Description of Related Art]

Various methods have been proposed as the COB (Chip On Board) method of mounting a semiconductor device on a board, based on purposes and uses of the semiconductor device. A flip-chip mounting method is one of the methods proposed as the COB method. In this mounting method, a semiconductor device (a semiconductor chip) is directly mounted on a board without wires connecting the semiconductor device to the board. The flip-chip mounting method is also called a wireless bonding mounting method.

[0003]

A description will be given, with reference to Figs. 1A through 1F, of the flip-chip mounting method.

Pads 2, which are electrodes, are formed on a chip 1 (the semiconductor device) to be mounted on a board 3. Pads 4 which are parts of conductive wiring patterns are formed on the board 3 on which the chip 1 is to be mounted.

First, bumps are formed as shown in Fig. 1A. Referring to Fig. 1A, an end portion of a gold wire 5 is pressed on a pad 2 of the chip 1 and heated by a bonding tool so as to be joined to the pad 2. In this state, the gold wire 5 is then removed. As a result, a tear-drop shaped bump 6 is formed on the pad 2. On all the pads 2 of the chip 1, tear-drop shaped bumps 6 are formed in the same manner as that describe above.

[0004]

Next, the tear-drop shaped bumps 6 are flattened as shown in Fig. 1B. Referring to Fig. 1B, the tear-drop shaped bumps 6 are pressed on a flat plate 7 so that only a point end portion of each of the tear-drop shaped bumps 6 is subjected to the plastic deformation. As a result, the tear-drop shaped bumps 6 are shaped into bumps 6 having

substantially the same height.

Conductive paste is then transferred to a surface of each of the bumps 6 as shown in Figs. 1C and 1D. That is, the end portions of the bumps 6 are immersed in a layer of conductive paste 8 as shown in Fig. 1C and then pulled up therefrom as shown in Fig. 1D. As a result, a drop of the conductive paste 8 is adhered to the end portion of each of the bumps 6. The conductive paste 8 is made, for example, of epoxy resin in which a large amount of silver fillers are distributed. Due to the drop of the conductive paste 8, positive electrical conductivity can be maintained between each of the bumps 6 of the chip 1 and a corresponding one of the pads 4 of the board 3 when the chip 1 is mounted on the board 3.

[0005]

Next, adhesive 9 is applied to or printed on the surface of the board 3 so that the pads 4 are covered with the adhesive 9 as shown in Fig. 1E. A thermosetting insulating adhesive, made of material including epoxy resin as the principal ingredient, is used as the adhesive 9 to be applied to the board 3. In a state where the chip 1 is mounted on the board 3, the space between the chip 1 and the board is filled with the adhesive 9. As a result, the chip 1 and the board 3 are tightly joined to each other. In addition, a connecting portion in which each of the bumps 6 are joined to a corresponding one of the pads 4 is covered with the adhesive 9, so that moisture is prevented from entering the connection portion by the adhesive 9.

[0006]

Finally, the chip 1 is mounted on the board 3 as shown in Fig. 1F. Referring to Fig. 1F, the chip 1 is positioned so that each of the bumps 6 of the chip 1 corresponds to one of the pads 4 of the board 3. A thermopressing head then presses the chip 1 on

the board 3, so that each of the bumps 6 is pressed on a corresponding one of the pads 4 of the board 3. The adhesive 9 and the conductive paste 8 are thus hardened by the heat, so that the chip 1 is completely mounted on the board 3.

[0007]

[Problem to be solved by the Invention]

The board on which semiconductor devices are mounted is set and used in electronic equipment, such as a personal computer. Due to the heat generated by the semiconductor devices on the board, the interior of such electronic equipment is at a high temperature. Particularly, in a case where a processor operated at a high frequency is included in the semiconductor device, a large amount of heat is generated. On the other hand, in a case where the electronic equipment is not used, that is, a power supply of the electronic equipment is in an off-state, the interior temperature of the electronic equipment decreases to a room temperature.

[0008]

The interior temperature variation of the electronic equipment affects the connecting portion in which each of the semiconductor devices and the board are connected to each other as follows.

As shown in Fig. 2, due to the temperature variation, the adhesive 9 between the semiconductor device 1 (the chip) and the board 3 is thermally expanded and contracted, so that the volume of the adhesive 9 is varies. Of course, thermal expansion and contraction occurs in the board 3, the semiconductor device 1 and the bumps 6. However the rate of expansion (contraction) thereof is less than that of expansion of the adhesive 9. Thus, in a case where the temperature is increased, the volume of the adhesive 9 is increased and the increase of the volume of the adhesive 9 functions as a force to

increase the distance between the board 3 and the semiconductor device. As a result, a contact force of the bumps 6 to the pads 4 of the board 3 is decreased, so that an electric contact resistance between each of the bumps 6 and a corresponding one of the pads 4 is increased.

[0009]

Further, when the temperature is repeatedly increased and decreased, the electrical contact resistance is successively increased and finally a disconnection may occur between the bumps 6 and the pads 4.

The present invention is to provide a method of mounting a semiconductor device on a board so that even if the volume of adhesive between the semiconductor device and the board is varied by the variation of temperature, an increase of the electrical contact resistance of the semiconductor device to the board can be prevented.

[0010]

[Means for Solving Problem]

To solve the above-mentioned problem, the timing of pressing and releasing is concerned when bumps of a semiconductor device is pressed with heat on pads of a board after the semiconductor device is positioned. That is, in the process of pressing and heating an adhesive is hardened to maintain the pressure force of the bumps to the pads on a board.

[0011]

The present invention of Claim 1 provides a method for mounting a semiconductor chip component on a substrate by pressing so as to weld bumps of a semiconductor component and pads of the substrate and by hardening an adhesive filled between the semiconductor component and the substrate, said method characterized by welding the bumps to pads of the substrate by pressure before said adhesive is

hardened and by releasing that pressure welding after the adhesive is hardened.

[0012]

Thereby, the present invention provides a method of mounting a semiconductor device on a board so that even if the volume of an adhesive between the semiconductor device and the board is varied by the variation of temperature, an increase of the electrical contact resistance of the semiconductor device to the board can be prevented.

In addition, to reduce the time consumption to mount a semiconductor device on a board is important to cut production cost. Thus, according to the present invention a head for pressuring and heating is preheated by a heater at a temperature sufficient to harden an adhesive so that the time period required until the adhesive is hardened is reduced. The head is released from pressing the semiconductor device after the adhesive is hardened and pressure force of the bump to the pad is maintained.

[0013]

That is, the present invention of Claim 2 provides a method for mounting a semiconductor component on a substrate by moving a head for heating and pressuring, which supports the semiconductor component, so as to weld bumps of the semiconductor component and bumps on the substrate by pressure and hardening an adhesive filled between the components and the substrate by heat from the head, said method characterized by moving the head, which is heated to reach temperature at which said adhesive is hardened, so that the bumps press the pads before the adhesive is hardened, and by releasing a pressure welding after the adhesive is hardened.

[0014]

According to the present invention, the

adhesive can be hardened in a shorter time period. Also, since the bumps are pressed on the pads with a pressing force of a predetermined value before the adhesive is completely hardened, the bumps can be securely joined to the pads so as to provide a sufficient contact area. Thus, even if the hardened adhesive is expanded and contracted by the variation of temperature, the electrical contact between the bumps and the pads can be maintained.

[0015]

[Mode for Carrying out the Invention]

A description will be given, with reference to Figs. 3 through 5, of a mounting method according to an embodiment of the present invention.

Referring to Fig. 3, a chip 31 (the semiconductor device to be mounted) is supported by a thermopressing head 30. The chip 31 is mounted on a board 33 by an operation of the thermopressing head 30.

The thermopressing head 30 is movable in directions indicated by arrows in Fig. 3 and provided with a heater 301 and a vacuum cavity 302. The heater 301 is supplied with an electric current from a power supply. The heater 301 generates an amount of heat sufficient to warm up adhesive 39 (which will be described later) to a temperature needed to harden the adhesive 39. The vacuum cavity 302 is connected to a vacuum system (not shown) so as to support the chip 31 by a suction force of the vacuum.

[0016]

A bump 36 made of gold (Au) is formed on a pad 32 of the chip 31. The bump 36 has a bowl-shaped root portion and an end portion.

An end of a gold wire is pressed on the pad 32 and heated by a bonding tool so as to be joined to the pad. The gold wire is then removed. As a result,

the bump 36 having a tear-drop shape is formed on the chip 31. The point end portion of the tear-drop shaped bump 36 is flattened. Conductive paste 38 is then transferred to or printed on the surface of the flattened end portion of the bump 36. The conductive paste 38 is made of a thermosetting resin, such as the epoxy resin, in which silver (Ag) fillers are distributed. The conductive paste 38 transferred to the flattened end portion of the bump 36 is preheated so as to be in a semi-hardened state.

[0017]

The surface of the chip 1 opposite to the surface on which a circuit is formed is held in position by the vacuum cavity 302, so that the chip 31 is supported by the thermopressing head 30.

The board 33 is positioned and fixed on a table 40. A pad 34 which should be electrically connected to the bump 36 is formed on the board 33. The pad 34 is generally made of copper (Cu).

[0018]

The adhesive 39 is applied to the surface of the board by using a dispenser or a printing technique. The adhesive 39 is made of thermosetting insulating resin including epoxy resin as the principal ingredient. The adhesive 39 has a heating characteristic by which liquidity of the adhesive is produced by an initial heating stage and then is gradually hardened with increasing temperature.

[0019]

Thus, since liquidity of the adhesive 39 applied to the whole surface of the board 33 is temporarily produced when the chip 32 is pressed on the board 33 by the thermopressing head 30, the adhesive 39 is prevented from flowing between the bump 36 of the chip 32 and the pad 34 of the board 33. The adhesive 39 may be applied to the surface of the board 33, except for the pad 34, by using the

printing technique.

[0020]

Fig. 4 is a timing chart indicating a time variation of the temperature and pressure in a thermopressing step. In Fig. 4, the axis of the abscissa indicates the time t and the axis of ordinate indicates the temperature T and the pressure P.

In a state where the chip 32 is set in the thermopressing head 30, the thermopressing head 30 start to go down toward the table 40. The chip 32 is pressed on the board 33 by the thermopressing head 30. While the thermopressing head 30 is going down, the contact pressure PP of the bump 36 of the chip 32 to the pad 34 of the board is gradually increased from a time t_0.

[0021]

In addition, the temperature TT of the adhesive 39 is gradually increased from room temperature RT. The reason is that the thermopressing head 30 is preheated by the heater 301 at a temperature sufficient to harden the adhesive 39.

While the temperature TT of the adhesive 39 is gradually increased, liquidity of the adhesive 39 is temporarily produced, that is, the viscosity of the adhesive is decreased. Thus, the adhesive 39 applied to the surface of the pad 34 is eliminated by the bump 36 being pressed on the pad 34. As a result, the adhesive 39 will not be present between the bump 36 and the pad 34.

[0022]

While the thermopressing head 30 is moving further down, the contact pressure PP and the temperature TT of the adhesive 39 are increased. The thermopressing head 30 stops movement at a time t_1 and is maintained at the position.

At this time (t_1), the contact pressure PP of

the bump 36 to the pad 34 is maintained at a value PA shown in Fig. 5.

[0023]

Fig. 5 shows a relationship between the contact pressure P and the electrical contact resistance R between the gold (Au) and the copper (Cu). In a region in which the contact pressure P is small, the electrical contact resistance is large. This region means that the connection between the gold and the copper is inferior. When the contact pressure P is increased and reaches a value equal to or greater than P1, the electrical contact resistance rapidly decreases. This state means that the connection between the gold and the copper is favorable.

[0024]

The value PA at which the contact pressure PP of the bump 36 to the pad 34 should be controlled is set so as to be greater than the value P1. For example, it is preferable that the value PA is set at 30 grams. The value PA of the contact pressure PP is a value sufficient to provide plastic deformation to not only the end portion of the bump 36 but also the root portion of the bump 36. In addition, due to the contact pressure PP at the value PA, the pad 34 of the board 33 is subjected to plastic deformation by the bump 36.

[0025]

At the time t_1, the temperature TT of the adhesive 39 does not reach a hardening temperature HT at which the adhesive 39 should be hardened. At a time t_3, the adhesive 39 starts to be heated at the hardening temperature HT.

Until the time t_3, the adhesive 39 is gradually hardened. From the time t_3, the adhesive 39 is heated at the hardening temperature HT so as to be rapidly hardened. A time needed to completely harden the adhesive 39 depends on ingredients of the

adhesive 39 and is, for example, within a range between 15 seconds and 20 seconds.

[0026]

Until the adhesive 39 is completely hardened, the thermopressing head 30 maintains the bump 36 in a state in which it is pressed on the pad 34 with a contact pressure PP of the value PA.

At a time t4, after the adhesive 39 is completely hardened, the vacuum cavity 302 of the thermopressing head 30 is returned to atmospheric pressure so that the chip 32 is released from being supported by the thermopressing head 30. The thermopressing head 30 then starts to go up. Since the adhesive 39 is released from being heated by the thermopressing head 30, the temperature of the adhesive 39 is gradually decreased to the room temperature RT.

[0027]

With decreasing of the temperature, the volume of the adhesive 39 is decreased, that is, the adhesive 39 is contracted. Thus, it is expected that the contact pressure is temporarily decreased immediately after the head 30 goes up and is separated from the chip 31. However, due to the contraction of the adhesive based on the decreasing temperature, a tension force is generated between the chip 31 and the board 33. As a result, the pressure force of the bump 36 to the pad 34 returns to and can be maintained at the initial value PA.

[0028]

Thus, in a state where the chip 31 is used inside electronic equipment, even if the adhesive 39 is expanded and contracted based on the variation of the temperature, a decrease of the contact pressure of the bump 36 to the pad 34 can be limited to a minimum value. As a result, the reliability of the electrical connection of the chip 1 with the board

33 can be maintained.

[0029]

The thermopressing head 30 from which the chip 32 has been separated is maintained at the hardening temperature of the adhesive. In the manufacturing process, the next chip is then supported on the thermopressing head 30 by the vacuum suction force.

[MODIFICATIONS OF THE EMBODIMENT]

In the above embodiment, the conductive paste 38 covering the surface of the bump 36 is made of resin in which silver fillers are distributed. However, the conductive paste 38 may be made of anisotropic conductive adhesive in which capsules are distributed, each of the capsules being formed by covering silver articles with resin. In this case, the cover of each of the capsules is broken when the bump is pressed on the pad. The silver articles being positioned between the bump and the pad.

[0030]

In addition, the electrical connection between the bump 36 and the pad mainly depends on the direct contact of the bump 36 with the pad. The conductive paste 38 is additionally used for the electrical connection between the bump 36 and the pad. The conductive paste 38 is not necessarily needed.

The bump 38 may have a shape (e.g., a cylindrical shape) other than a shape having the bowl-shaped root portion and the end portion as described above.

[0031]

The adhesive 39 may be heated by a heater provided near the table, as a substitute for the heater 301 mounted in the thermopressing head.

The adhesive 39 is previously applied to the board 33. After the bump 36 is pressed on the pad, the adhesive 39 may be put into the space between the chip and the board. However, it is preferable

that the adhesive 39 is previously applied to the board 33 before the bump 39 is pressed on the pad as described in the above embodiment.

[0032]

[Advantage of the Invention]

According to the present invention, since the bumps are pressed on the pads with a pressing force of a predetermined value before the adhesive is completely hardened, the bumps can be securely joined to the pads so as to provide a sufficient contact area. Thus, even if the hardened adhesive is expanded and contracted by the variation of temperature, the electrical contact between the bumps and the pads can be maintained.

[0033]

Further, since the thermopressing head is preheated at a temperature at which the adhesive can be hardened, the pressure of the bumps against the pads by the head reaches a predetermined value before a temperature of the adhesive reaches temperature at which the adhesive is hardened, and the pressure is released after the adhesive is completely hardened, the adhesive is heated much faster and thus the time required for mounting is shortened.

[Brief Description of Drawings]

[FIG.1]

Diagram illustrating a procedure of mounting a semiconductor device on a board.

[FIG.2]

Cross sectional view showing a connecting portion in which the semiconductor device and the board are connected to each other.

[FIG.3]

Diagram illustrating a relationship between the board and the semiconductor device supported by a head used in a thermopressing step.

[FIG.4]

Timing chart illustrating a variation of contact pressure of a bump to a pad and a variation of adhering temperature.

[FIG.5]

Characteristic diagram illustrating a variation of contact resistance to a variation of contact pressure between gold (Au) and copper (Cu).

[Description of Reference Numerals]

1 and 31	a semiconductor device (a chip)
2 and 32	pads on a semiconductor device
4 and 34	pads on a board
6 and 36	bumps
8 and 38	conductive paste
9 and 39	an adhesive
30 and 30A	a thermopressing head
301	a heater
40	a table
HT	hardening temperature
RT	room temperature
PA	pressure of a bump to a pad

[Title of Document] Abstract

[Abstract]

[Problem]

It is a general object of the present invention related to a method of mounting a semiconductor device having bumps on a board having pads to prevent an increase of the electrical contact resistance of the semiconductor device to the board from an increase of the volume of an adhesive between the semiconductor device and the board by the variation of temperature.

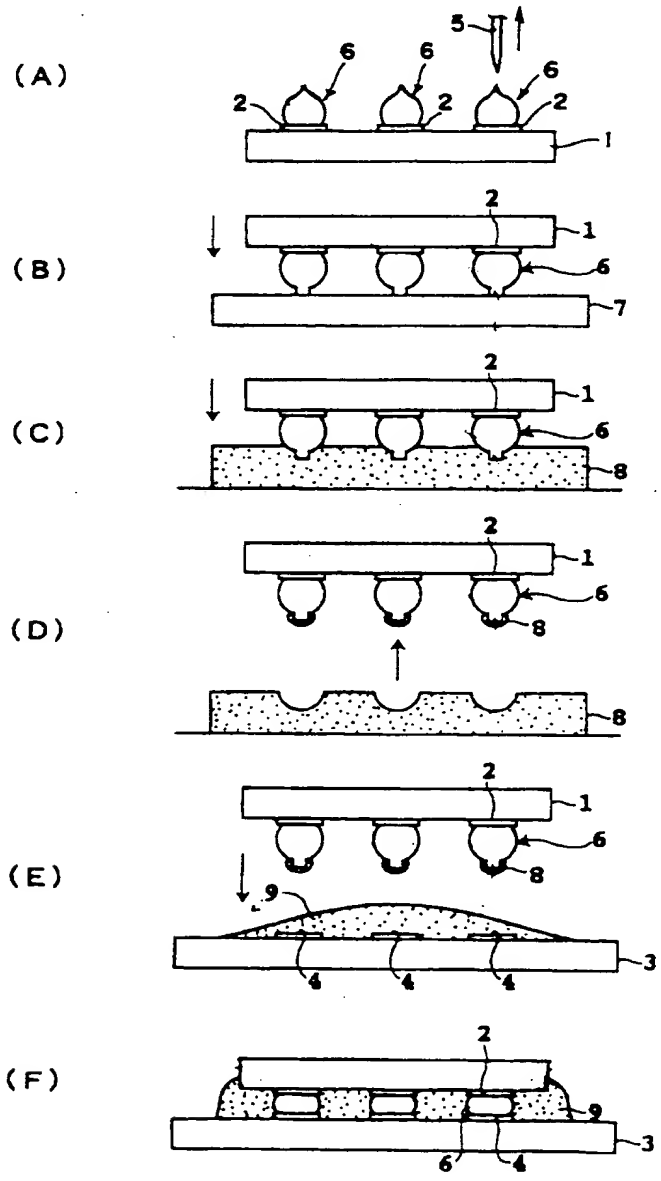
[Solving Means]

A method of mounting a semiconductor device having bumps on a board having pads so that each of the bumps is joined to a corresponding one of the pads is provided. Adhesive to be hardened by heat is provided between the semiconductor device and the board. The method includes the steps of pressing the bumps of the semiconductor device on the pads of the board, and heating a portion in which each of the bumps and a corresponding one of the pads are in contact with each other. A pressure of the bumps to the pads reaches a predetermined value before a temperature of the adhesive to which heat is supplied in the above step reaches a temperature at which the adhesive is hardened.

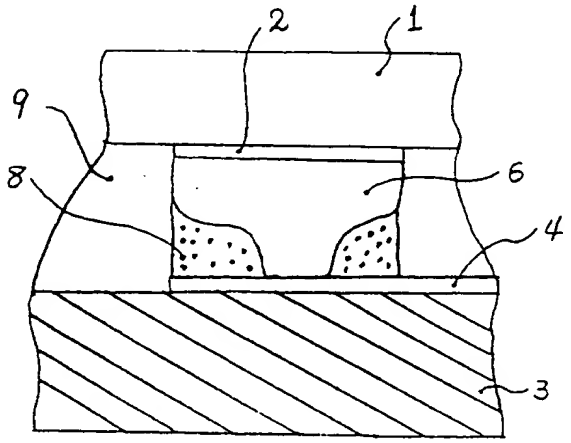
[Selected Drawing] FIG. 4

[Type of Document] Drawings
【書類名】　図面

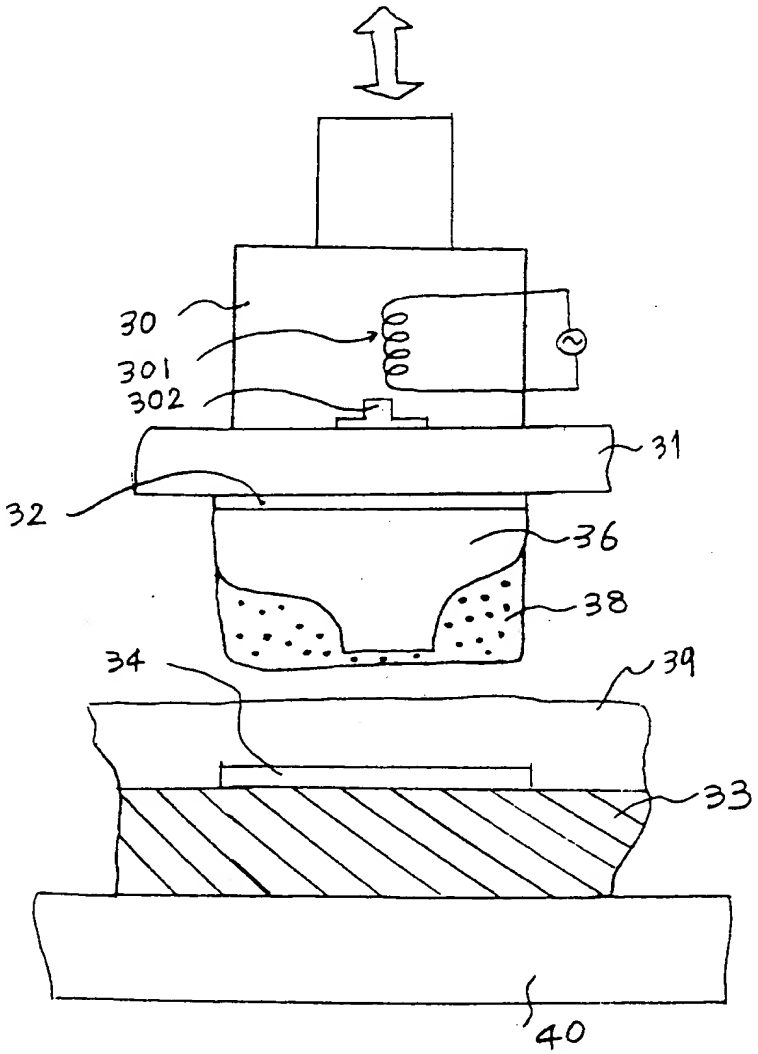
【図１】 [FIG. 1]



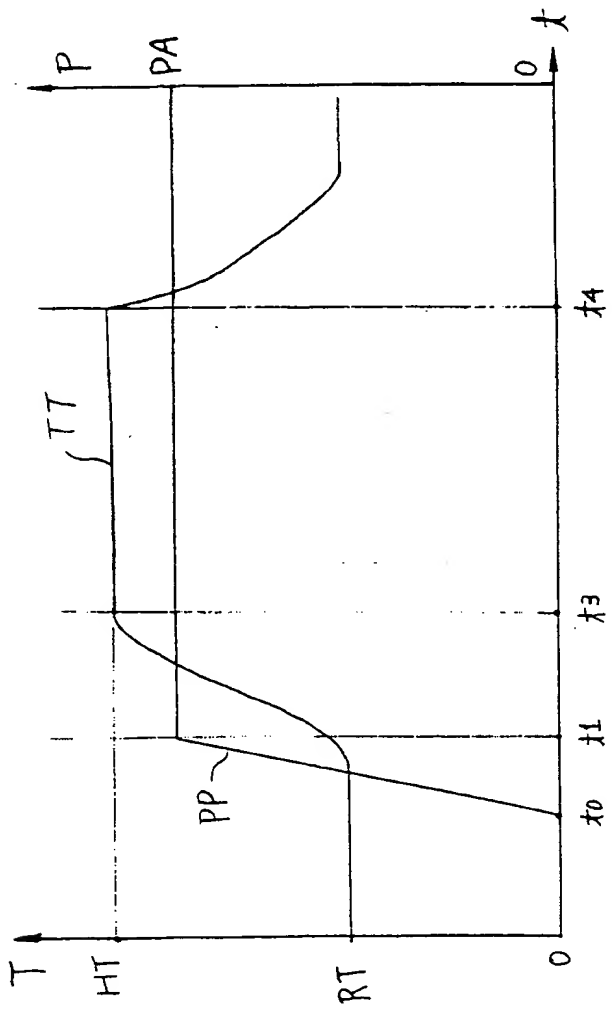
【図２】[FIG. 2]



【図３】 [FIG.3]



【図４】[FIG.4]



【図５】 [FIG.5]